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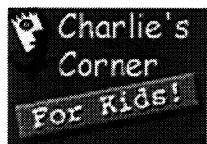
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A Beginner's Guide to Reviewing EHS Issues at Your School

(The following was developed by the Burlington (Massachusetts) Board of Health and identifies 25 important items that should be reviewed and considered when initiating an Environmental, Health and Safety assessment.)

1. Provide your staff with basic chemical hygiene and right to know training prior to initiating your review. This training should include instructions on how to review a material safety data sheet as well as identifying common chemical hazards. The assistance and support of the staff will make your effort easier.
2. Prepare an inventory of all the chemicals maintained by each school and each department within each school system. Remember that chemicals are present in all schools. This record should include the following information: chemical name, name of the manufacturer, where the material is stored (room number, building), container size, hazards associated with the material, date completed, and the name of the individual completing the inventory.
3. Inspect and verify the accuracy of the chemical inventories prepared. Check all schools, all rooms, shelves, closets, cabinets, boxes, every nook and cranny.
4. Acquire a copy of the material safety data sheet for each item present in your chemical inventory.
5. Review the inventory for obvious chemical overstocking or locally unacceptable chemical hazards. Seek the input of the local health officials and fire department. *(Note: A general list of some hazardous materials commonly considered a safety risk for school use is provided in the [Chemical Management](#) section of the case study.)*
6. Have the staff review the inventory to determine if there are any materials that are no longer used.
7. Arrange for the disposal of the materials identified in items 5 and 6.
8. Review how the chemicals are stored. Centralized and secured storage is the best. Unsecured storage in the classroom may enable a prankster to tamper with or steal materials. Also, seek the input of the local fire department to ensure the materials are protected in the event of a fire.
9. You may also wish to discuss or establish a policy which outlines which chemicals are not acceptable to your school district.
10. Review how hazardous waste is both generated and disposed. Hazardous waste manifests should be available.
11. Prepare guidance informing your staff what hazardous waste is and how to handle it. A centralized collection and disposal effort should be established.
12. Train your staff in the handling, labeling and disposal of hazardous waste.



13. Review maintenance and calibration records for all potential indoor pollution sources (e.g. kilns, chemical hoods, and spray booths). This should occur on an annual or biannual basis.
14. Smoke test all potential indoor pollution sources to test for leaks and failures. Remember to coordinate with the fire department.
15. Attempt to identify potential indoor emissions or pollutants in the school (e.g. procedures which result in the release of chemical odors or nuisance dusts into the school - spray painting, chemical reactions involving volatile materials, ceramics, etc.).
16. Review safety issues associated with the curriculum. Are harmful gases or dusts generated? Are corrosive or flammable materials used? Should personal protective equipment such as gloves or safety glasses be used?
17. Inspect the classrooms, laboratories, and shop areas to determine if protective equipment is available and if the equipment is being routinely used.
18. Have OSHA compliant eyewash units been provided in all areas where corrosive materials are routinely stored and used? Are eyewashes present where other hazards exist?
19. Are the eyewash units inspected and tested on a weekly basis?
20. Have deluge showers been provided in areas where significant fire hazards exist?
21. Are the showers being inspected and tested on a monthly basis?
22. Have all the fire extinguishers been inspected and tested within the past year?
23. Have the natural gas jets located in the classrooms been locked out and rendered inoperative when not in use?
24. Has the school established any contingency plans for handling chemical spills that may occur at the school? Identify the types of spills that could occur and the spill response supplies needed (e.g. mercury, acid/base, flammable liquid, oils, etc.).
25. Establish a spill plan and train your staff accordingly.

*Prepared by Todd H. Dresser
Environmental Engineer Burlington Board of Health
29 Center Street Burlington, MA 01803
(781)270-1956
e-mail: tdresser@burlmass.org*

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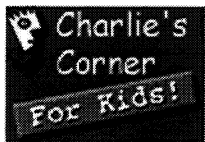
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Chemical Management & Usage

I. The issue:

Proper chemical management is critical to preventing and/or controlling a variety of Environmental, Health and Safety (EHS) issues within any facility. The first step towards initiating proper chemical management is the creation of an accurate chemical inventory along with a copy of the material safety data sheet (MSDS) for each item listed on the inventory. An MSDS is an informational document prepared by the chemical manufacturer or distributor which describes chemical, environmental, and health and safety information available for a particular compound. Understanding the materials present at the school will enable you to understand the issues associated with these substances. Properly recognizing and controlling the hazards inherent to these materials will enhance your ability to create a safe school with minimal environmental liabilities. Failure to properly manage your materials can create a myriad of difficult and interrelated EHS issues.

II. The approach taken:

My effort began with a request for an accurate chemical inventory from all sections of the school department and a review of their chemical handling practices. This action was prompted by a history of chemical incidents occurring in the high school. In the 1970's, the chairman of the high school science department discarded ammonium phosphide, a water reactive material, via the sanitary sewer which resulted in the destruction of a portion of the sanitary sewer when the material detonated. The indoor air quality of the school was also compromised during this event by the generation of phosgene gas (a basic chemical warfare agent). In 1991, a fire in the facilities maintenance warehouse at the high school became a serious hazardous materials incident when pallets of bleach, ammonia and sulfuric acid based drain cleaner stored adjacent to each other ruptured and created an acid vapor cloud and chlorine and phosgene gas. The total cost of this event was approximately \$500,000.

In order to initiate a hazard analysis of the school system, it was imperative to identify the number, type, volume, and location of the hazardous materials present throughout the school system. The preparation of the chemical inventories provided this basic information. Using this information, I was then able to identify and prioritize the hazards present throughout the school system as a means to most effectively respond to the problems detected.

III. Observations made:

This was a difficult and time consuming task. It took nearly four years to acquire a complete and accurate inventory from all departments within the school system. The staff and administration did not realize initially how decentralized the purchasing, storage and usage of chemicals had become. Chemicals were found to be stored throughout all areas of the high school. The middle school and elementary schools were better able to locate and identify their chemical inventories, but this was primarily due to the reduced size of their inventories and its limited use within certain areas of the school. The presence of the facilities maintenance department, and an active arts and science departments acted to significantly increase the size and scope of the chemical inventory at the high school.

The lack of centralized purchasing and storage hindered the ability of the school department to track and account for the materials in their inventory. In addition, it was impossible for the school system to ensure its compliance with the Massachusetts Right to Know law. This law is similar to the federal Hazard Communication Standard which requires each employer to maintain a chemical inventory and MSDS database as a means to identify chemical hazards in the workplace and to train and inform their staff of these hazards.

Another problem associated with decentralized purchasing was that the school system tended to purchase an excessive amount of chemicals. Frequently, staff members were purchasing materials that were already present somewhere within the school system. This represented an inefficient use of school funds and created additional regulatory requirements and safety hazards as the materials accumulated.

A decentralized approach to chemical management and accounting also hindered our ability to respond to an accident or to prevent theft or tampering. This problem was noted during the 1991 fire in the facilities maintenance warehouse. Confusion over what materials were present in the warehouse and the inability to locate MSDS's for materials thought to be present created the need for firefighters to conduct an extremely hazardous exploratory entry to determine what materials were involved in the fire. Proper training, equipment and luck prevented this effort from becoming a tragedy. An increasingly important concern is the need to protect your chemical inventory from theft and tampering. Many of the chemicals commonly found in an educational setting could easily be used in a more threatening manner by a prankster. Furthermore, the school department and individual teachers can be subject to civil liability if they are found to be negligent in their storage and control of chemicals. So if, the local juvenile delinquent walks away with a container of sodium you had stored on a shelf in your classroom and injures himself, then the teacher and the school system can be held liable for the injuries and suffering resulting from the thief. This was a major concern in the high school science area where an average of approximately 150 chemical containers were found initially stored in each classroom. These materials were routinely stored on shelves or in unlocked cabinets or drawers.

Another observation noted was that the school system had a policy of accepting chemical donations. Many thought this was prudent due the declining school budget. In actuality, the school became a dumping grounds for local businesses especially those that were terminating operations or relocating. As a result, the high school science department collected a large volume of chemicals more useful for electroplating than for the teaching of high school chemistry. The facilities maintenance staff also suffered from this policy by collecting a large number of product samples or promotional products. Products found to be ineffective by the maintenance staff were frequently consigned to a corner of the warehouse and forgotten. Over time, this resulted in the accumulation of a large volume of flammable petroleum based cleaning materials.

Finally, no consideration was given during the acquisition process for the eventual need and cost of disposal of chemicals or the health and safety issues associated with the material. Furthermore, little awareness existed of the need to train and advise the staff how to use, store or dispose of the materials. This lapse in oversight and training resulted in the creation of numerous safety hazards associated with improper chemical storage as well as the repeated disposal of hazardous waste via the sanitary sewer.

IV. The problems or concerns noted:

- The lack of knowledge regarding what chemicals we had, what hazards were associated with these materials, and where the material was stored.
- The accessibility of the materials, and the risk of accident or thief this accessibility presented.
- The inherent risk created by the massive volume of chemistry maintained by the school department.
- The potential toxicity, flammability or reactivity of the individual chemicals maintained by the school department.
- The lack of functioning protective equipment, and health and safety practices in the schools.

- The inefficient use of funds created by overstocking materials.
- The staff's limited understanding of the hazards associated with the chemicals.
- The impact of the acceptance of chemical donations by the school department.

V. Actions taken:

High School Science Department

A. EHS evaluation of the chemical inventory.

In 1993, I reviewed chemical inventory maintained by the high school science department for EHS issues. As a result, I determined that 40% of the inventory were human carcinogens, teratogens (capable of causing birth defects), and mutagens (capable of causing genetic damage). I also noted that the chemistry curriculum was heavily involved with the use of organic solvents such as benzene (volatile, flammable and carcinogenic), carbon tetrachloride (volatile and carcinogenic) and carbon disulfide (volatile, flammable, narcotic poison). During my review, I also noted the presence of a number of acutely toxic materials (e.g. cyanide salts and bromine gas), radioactive materials (e.g. thorium nitrate and uranium tetrachloride), and potentially explosive materials (e.g. ethyl ether and cumene). In addition, many of the components of the science department inventory posed lesser hazards due to their individual corrosivity, toxicity or reactivity.

One major problem I noted during this evaluation was that the material safety data sheets (MSDS) provided by firms specializing in supplying chemicals to schools were frequently inadequate in terms of quality and detail. All reviewers should beware of MSDS's that frequently contain omissions within the body of the document or repeatedly list 'not applicable' especially for common materials. I also recommend that you notify your supplier or the federal Occupation Safety and Health Administration if you notice a repeated trend in poor quality or vague MSDS's. Remember depending on your setting, state and/or federal hazard communication requirements specify your responsibility to identify and address the hazards associated with the materials you use. If the manufacturer does not properly identify these concerns, then you may be required to research it more thoroughly. The bottom line is to demand better service and information from your supplier or find a new supplier.

Once the size, scope and location of the chemical inventory had been established, we were now in a position to proceed with addressing the EHS concerns created by the material.

B. Terminated chemical donations.

One of the first steps taken to prevent the continued acquisition of extremely toxic and hazardous materials with limited educational value was to ban the acceptance of chemical donations. A more than twenty year practice of accepting chemical donations had resulted in the accumulation of a large volume of material better suited for metal plating and the manufacture of electronics than the instruction of high school chemistry. In an effort to enhance their inventory without impacting their budget, the science department had willingly accepted material from local industry. The staff accepted the good with the bad, frequently without reviewing what exactly they had received. The net result was the creation of a huge and extremely hazardous chemical inventory. The size and scope of this inventory also made it impossible for the science department to comply with the Massachusetts worker right to know requirements.

The termination of this practice signaled the first effort to control the influx of new materials. This was an extremely important step because the cost of chemical disposal alone is frequently two to three times the cost of purchasing the materials. The possession of certain chemicals may also trigger additional regulatory requirements or unique storage issues. I encourage all school systems to adopt a similar policy to prevent your schools from becoming a chemical disposal option for local industry and to prevent a right to know compliance nightmare.

C. Established a centralized chemical storage policy.

After identifying the major hazards associated with the chemical inventory, our next step was to implement a centralized chemical storage policy in order to enhance chemical control and accountability, and to remove the chemical hazards from the classroom. Even though a centrally located, secured and ventilated chemical storage room equipped with a carbon dioxide fire suppression system had been constructed within the science area, the staff had opted to store the bulk of their inventory in their classrooms for convenience. During a comprehensive inspection, we found unsecured materials stored in the closets, cabinets, desks, and on shelves in each classroom and preparation area. The majority of the materials were readily accessible. In most cases, these materials were stored in an random manner.

The historic chemical storage practices of the department posed a major obstacle to our effort to comply with state right to know requirements and to prevent the theft of materials. This method of storage also increased the likelihood of a serious hazardous materials incident occurring in the classroom due to the storage of chemicals in areas not designed or equipped to provide additional protection in the event of a fire. This risk was compounded further by the common practice of the storing the materials without regard to chemical compatibility or reactivity.

We resolved these problems by relocating the entire inventory to the chemical storage room originally designed and constructed for this purpose. During this process, we used the chemical storage protocol outlined by Flinn Scientific as our guide to ensure that the materials were stored properly with regard to chemical compatibility and reactivity concerns. This task allowed us to immediately identify the true size of the chemical inventory and prompted a major disposal effort when we realized our inventory vastly exceeded our storage capacity.

D. Established a chemical disposal policy and conducted a massive chemical removal.

After reviewing the hazards associated with inventory, and the laboratory facilities at the school as well as the history of accidents and near misses at the school, the Burlington Board of Health ordered the science department to dispose of all confirmed carcinogens, teratogens, mutagens and acutely toxic materials. The Board of Health also recommended that the department dispose of all materials no longer used by the staff, contaminated or degraded materials, and where possible to reduce the volume of overstocked items. As a result, 65 drums and containers of hazardous waste were disposed of during a one time clean out conducted in September 1993. The following is a sampling of materials disposed of at this time:

- 0.5 lbs of chloral hydrate, a controlled barbiturate
- 3.5 lbs of unsealed radioactive materials including thorium nitrate and uranium tetrachloride
- 42 one liter glass cylinders containing bromine gas
- 12 containers of various potentially explosive peroxide forming materials (e.g. ethyl ether, dioxane, formic acid, cumene, furan, tetrahydrofuran, sodium peroxide, barium peroxide, and potassium metal)
- 7 lbs of water reactive metals: sodium, lithium and potassium
- 5.5 lbs of cyanide salts
- gallons of benzene, carbon tetrachloride, chloroform, aniline, and formaldehyde
- 10 lbs of elemental mercury, and 3 lbs of mercuric compounds
- 5 lbs of explosive white phosphorus
- 5 lbs of potentially explosive potassium chlorate
- 1 lb of polychlorinated biphenyl's (PCB's)
- 3 lbs of powdered cadmium
- 1 LB of powdered arsenic
- 2 lbs of powdered antimony
- 1 gallon of o-toluidine
- approximately 100 lbs of potentially explosive oxidizers

At this time, we also adopted a five year review plan for each chemical. Using a five color coding system, we labeled all materials to indicate their approximate date of purchase. The color coding system is designed to quickly identify the date of purchase

and age of each container in the inventory. It is now the responsibility of the chairman of the science department to review each chemical container on the fifth year of its purchase to determine if the material should be retained or discarded. This evaluation is based on the EHS issues associated with the material, whether the material is still being used by the department, and the integrity or quality of the material. We hope that this approach will aid our efforts to prevent the chemical overstocking observed in the past.

E. Provided staff with training.

Another key component to addressing our chemical hygiene problems was to provide the staff with basic training in chemical hygiene and EHS awareness. A main component of this effort was to review how to read and understand an MSDS as well as learning to interpret the quality of an MSDS. This was extremely critical because I found that the majority of the staff had no formal training or knowledge in this area. This was compounded by the staff reliance on textbooks or chemical supply catalogs which did not mention EHS issues or provided erroneous recommendations. Habit was also a significant barrier to change and improvement. Much of the staff was resistant to change even after the health and safety issues of certain activities had been reviewed in detail. As a result, I have modified the training regimen to include a discussion of the types of liability associated with accidents involving chemical usage in schools.

F. Established centralized chemical purchasing.

We also established a centralized chemical purchasing system where the chairman of the science department became responsible for reviewing chemical purchases. The intent of this plan is to ensure that chemicals are reviewed for the following parameters prior to purchasing: 1) hazards associated with the material, 2) potential impact on air quality, 3) generation of hazardous waste, and 4) the availability of less toxic alternatives. This initiative is designed to prevent over stocking and the acquisition of inappropriate materials. The effort has also enhanced our ability to maintain an accurate chemical inventory and MSDS database as required by the Massachusetts Right to Know law.

G. Banned the disposal of regulated chemicals via the sanitary sewer.

During routine inspections, I noted that the staff repeatedly disposed of state and federally regulated hazardous waste via the sanitary sewer. Our first attempt to address this problem was to advise and train the staff with regard to the discharge requirements established by the local sewer authority. This effort met with limited success. As a result, the Board of Health adopted the position that it would issue citations and fines to individual teachers if they were caught discharging materials. The publicity associated with this position and the concern over incurring a \$200 fine provided the motivation to reduce the discharge of hazardous waste via the sanitary sewer.

H. Established a hazardous waste management plan.

A hazardous waste management plan was also developed as a means to promote the identification, collection and proper disposal of all hazardous waste generated by the staff. The staff were instructed to review their procedures to determine what wastes were generated and how these materials had to be managed (acceptable for disposal via the sanitary sewer versus manifested disposal as a hazardous waste). In addition, a satellite hazardous waste storage area was also established in an isolated and secured portion of the science area. The staff was also instructed to ensure that all waste containers were to be kept sealed and labeled at all times. Depending upon the rate of generation, this waste material is relocated to the school's central hazardous waste storage area on a biweekly or monthly basis pending proper disposal.

I. Assessed classroom setting and availability of protective equipment.

Our safety evaluation also included a review of how the classrooms were equipped and the safety practices utilized by the staff. During this assessment, I found that the majority of the classrooms were not equipped with emergency eyewash units or

chemical fume hoods. In addition, I also noted that the units available appeared to be either unused or unmaintained. We also noted a significant shortage in terms of safety glasses, protective gloves and aprons. During training sessions, we reviewed the need to use and maintain various safety equipment. We also reminded the staff of the Massachusetts state law requiring the use of protective eyewear when chemicals are used in an educational setting. As a result of this review, new safety supplies were purchased so that each classroom was equipped with an emergency eyewash and an adequate amount of protective equipment. Unfortunately, the staff use of safety equipment continues to be spotty and not fully compliant with state requirements.

J. Investigation of the chemical fume hoods.

During my survey, I noted that the staff rarely used the chemical fume hoods in the science area. Upon closer examination, it became obvious that many of the units were in a state of disrepair. Our efforts to investigate and repair the fume hoods provides evidence of the need to hire a trained and competent professional to evaluate and maintain these units. During this review, we initially found that the exhaust fan had been removed from the majority of the units, presumably for energy savings. The remaining units were found to be equipped with improperly sized and balanced intake and exhaust fans. In addition, when tested with smoke, approximately half the units or associated ductwork were found to leak contaminants into the building. A final and fatal flaw was also detected for all chemical fume hoods. All hoods were found to be constructed with the exhaust located adjacent to the intake for each unit, consequently even if functional, the hoods could not remove contaminants from the classrooms and laboratories without reintroducing the materials to the building.

We have worked with an architect and certified industrial hygienist to correct and resolve these deficiencies. We have also provided the staff with additional training regarding the safe and proper use of the hoods. In addition, each hood has been labeled to indicate the safe work area within the hood as well as the proper sash height for safe operation.

An inexpensive tip for screening the function of a chemical fume hood is to test the unit using a 60 to 90 colored smoke bomb. If the unit is functioning properly it should easily evacuate the smoke to the outdoors. Common problems you may observe would be the failure of the smoke to exit the unit, smoke leaking from the hood or ductwork, and smoke reentering the intake or the building ventilation system. One word of caution would be to coordinate all smoke tests with your fire department to ensure that all area smoke detectors have been disabled prior to testing. This graphic and inexpensive demonstration can be a useful indicator of whether a serious problem may exist. This test does not replace the need to have the units tested and re-calibrated on annual basis by a competent professional. Also, all units found to display improper air flow should be removed from service until inspected and repaired.

K. Investigation of curriculum changes as a means to promote pollution prevention and improve air quality and classroom safety.

In addition to the actions noted, the science department has placed emphasis on researching and adopting a less toxic curriculum as a means to promote pollution prevention, and health and safety. This effort has focused on the elimination of the most toxic reagents as well as the implementation of microscale experiments as a means to reduce the volume of materials used or generated. This process has been supported by the adoption of a chemical use review policy which requires the staff to review each procedure with regard to: a) hazards associated with the activity, b) potential impact of air quality, c) protective equipment required, and d) the generation of hazardous waste. The School Committee has adopted a formal review policy which prohibits student use of any materials or the generation of any reaction byproducts which have a National Fire Protection Association (NFPA) hazard ranking of 4 or carcinogens. (The NFPA is a technical advisory group conducting research for fire prevention and hazardous materials mitigation. The NFPA has established a 0 to 4 hazard ranking scale for chemicals based on the flammability, reactivity and the health hazards associated with material. The level of hazard increases as you move from 0 (no hazard) to 4 (most severe hazard).) In addition, each teacher is now required to justify the use or generation of any material that may generate a substance with an NFPA ranking of 3.

High School Art Department

A. Reviewed issues associated with arts curriculum and chemical inventory.

A review of the art department indicated that the program consisted of the following activities: photography, computer graphics, painting, and ceramics.

Photography: Standard fixers and developers were found to be utilized by the photography lab. In addition, the use of protective equipment was observed to be a common practice in this area. The primary concerns for this area were proper ventilation and proper waste management. The common use of chemicals in a photolab that was not originally designed for this purpose has raised a number of concerns regarding proper ventilation of this space. These issues will be discussed in detail in the section related to indoor air quality. The waste generated in the photography lab is containerized for off site disposal. This appears to be the wiser practice because there is no encouragement to the staff or students to discharge the materials via the sanitary drains as would be the case if a neutralization system or silver recovery system were in place. By using off site disposal, we also avoid the need for acquiring a discharge permit from the local sewer authority and conducting compliance testing routinely required by discharge permits. The wastes are now managed as part of the hazardous waste management program adopted by the school system.

Computer graphics: The major hazards associated with the computer graphics laboratory are associated with electrical safety and potential impact on indoor air quality. The computer graphics lab has grown and expanded as society's use of the computer has grown. The concern for electrical safety is based on the constantly increasing accumulation and use of electrical equipment in an area not originally designed for this purpose. The presence of a large number of power cords and cables poses a serious fall hazard. There also exists the risk of toppling equipment should the cords or cables become caught on a moving object. The most serious electrical concern is the risk of creating a fire hazard by over loading an electrical circuit. These conditions are most appropriately reviewed by a licensed electrician.

Indoor air quality concerns also existed in the computer graphics lab. The accumulation and use of a large volume of electronic equipment in an area not originally designed for this activity resulted in degradation of the air quality in this area. We had three areas of concern: the generation of volatile organic contaminants evolving from the toners and inks used, the generation of ozone by the equipment, and the decline in the humidity in this area. The standardization of the toner and ink chemistry limits our ability to reduce the generation of the emissions from these materials. As a result, we hope to reduce the potential impact of these materials by increasing the rate of fresh air exchange in this area as a means to dilute and remove the contaminants. On a number of occasions, I have monitored the computer lab and measured temperatures ranging between 85 to 90 degrees Fahrenheit with humidity at 15% to 25%. The heat given off by the equipment combined with inadequate air exchange acts to heat the room and lower the humidity. As a result, this promotes the generation of hazardous ozone. Ozone is a significant respiratory irritant. The decline in humidity also increases the generation of static electricity in the area which can be detrimental to the equipment and annoying to the occupants. Also, a lower humidity level tends to cause soft tissues such as mucous membranes and the eyes to dry and become irritated. The generation of harmful ozone can be mitigated by lowering the temperature and increasing the humidity in the laboratory. This approach will also improve the comfort level for the occupants. We hope that by lowering the room temperature, increasing the ventilation rate, and increasing the humidity level that we will be able to address the three air quality concerns we have identified.

Painting: The bulk of the painting done by the department involves the use of water based materials, however, acrylics and aerosols are used. The only concern noted involving the use of water based materials is that some of these products have been found to contain heavy metals. Consumption or accidental ingestion of these materials is not considered a high risk by high school students but may be a greater concern for younger students. I also noted that it is difficult to review the health and safety of these products because many of the MSDS's generated for these products are frequently of

low quality and lacking in detail. When ordering supplies, you should confirm that the product complies with ASTM D4236, an art safety standard adopted by the federal Consumer Product Safety Council. In order to bear this seal, the product must undergo toxicity testing to confirm that it is safe for use by children. A sampling of this labeling can be found on most Crayola® products.

The use of acrylics and aerosols occasionally has resulted in the degradation of the air quality of the art studio and adjacent classrooms. We have provided the staff with right to know training and discussed the need to locate more benign products or to use the materials in a better ventilated area. This approach has met with limited success. In addition, we are also planning repairs and modifications to the existing ventilation system.

Ceramics: The high school has a very active ceramics program. As part of this curriculum, the students have been instructed in the art of mixing different types of clays and glazes using dry powdered components. This practice has created numerous significant respiratory hazards.

The most significant hazard is the generation of free silica dust. Free silica is a chemical cousin to asbestos with regard to physical qualities and health and safety effects. A review of the clay powders used by the department indicated that the products in their inventory typically contained between 20% to 90% free silica, and in some cases asbestos. The storage, handling and mixing of these powdered materials resulted in the airborne release of large quantities of free silica which has contaminated the ceramics studio, the ventilation system in the ceramics studio and adjacent class rooms. By converting to the use of premixed wetted clays, we were able to significantly reduce the generation of free silica in the ceramics studio. Unfortunately, free silica will continue to be produced when ever a dry piece of ceramics is sanded or sculpted. The school department has attempted to address this hazard by conducting these activities in a chemical fume hood. The size of the free silica particles decreases the likelihood that this approach will be effective at controlling or removing the free silica from the classroom. Aside from eliminating these activities or conducting them outdoors, the most effective means for controlling the free silica hazard is to implement a rigorous daily cleaning regimen which involves the damp mopping or HEPA vacuuming of all surfaces in the work area. A HEPA vacuum is a high efficiency particulate vacuum used to remove extremely small particles while also filtering its exhaust so that fine materials are not released. Warning - Do not use standard household type vacuums to collect free silica because these units are not capable of collecting and retaining the silica and will act to transport the problem throughout the building.

The mixing of glazes and englobes also resulted in exposing students to a number of severe respiratory hazards associated with the use of toxic heavy metals. The students and staff used a variety of powdered metals (e.g. chromium, cobalt, nickel, and titanium) to prepare various colorants. These actions exposed the user to a variety of potential carcinogens, mutagens, and teratogens. This activity also resulted in the release of the materials to the classroom and the ventilation system. We resolved this issue by training and informing the staff and administration of the hazards created by this activity and by using premixed manufactured glazes and englobes with limited heavy metal content.

In addition, all extremely hazardous metallic powders and dry powder clays have been removed from use in the classroom and disposed of in accordance to state and federal requirements. During this effort, we disposed of several hundred pounds of clay powders and approximately 100 pounds of various heavy metal powders.

B. Inspection of the kilns used by the ceramics program.

The high school art department maintains two kilns which are located in an interior room lacking a window. Proper venting of the kilns is critical due to the degradation of indoor air quality caused by the generation of carbon monoxide, volatile organic compounds, and metallic vapors. Initially, the kiln room was vented to the outdoors via a manually operated ceiling mounted exhaust fan which was ducted thirty feet to the outdoors. The discharge for this ductwork was 10 feet below the roof line within a partially enclosed area and adjacent to the discharge was an inoperative louver fan for

the ceramics studio. The following problems existed with this design. First, the kiln exhaust was not ducted to the exhaust fan but allowed to passively be drawn to the fan. This approach allowed the kiln emissions to escape the kiln room via two door ways or via the building heating and ventilation system which also serviced the kiln room. In addition, the operation of the exhaust fan was manually operated by the staff and students and due to its noisy operation most individuals preferred not to use the fan. Furthermore, it was questionable that the exhaust fan was capable of transporting captured emissions the required thirty feet and discharging the material via the louvered opening. Finally, it is likely that a portion of those materials that were discharged by the exhaust system probably reentered the building via the louvered fan located adjacent to the kiln exhaust discharge.

We addressed these problems by installing bottom mounted exhaust fans on both kilns. The kiln exhausts were also ducted directly to the existing exhaust system which was equipped with two quieter booster fans. The exhaust system was also modified to discharge above the roof line. The exhaust system has also been hard wired to operate when the kilns are in operation.

C. Improved chemical storage to prevent tampering or thief.

Efforts have been initiated within the art department to improve chemical management and control. Several flammable storage cabinets have been purchased and the bulk of the chemical inventory has been moved from classrooms to secured storage closets and cabinets.

D. Established a chemical use review policy.

A chemical use review policy has been adopted which requires the art department chairman to review the materials and procedures involving the use of chemicals for the following parameters: a) health and safety concerns, b) impact on air quality c) need for protective equipment, and d) the generation of hazardous waste. The materials used by the art department are also subject to the review and consideration of the School Chemical Oversight Committee.

E. Established a hazardous waste management plan.

All hazardous wastes generated by the art department are now forwarded to the care of the facilities maintenance staff which manages the overall hazardous waste management plan adopted for the school. A satellite hazardous waste storage area has been established in the photolab for the waste fixer and developer generated in this area. All other waste is transferred to the central hazardous waste storage area as it is generated.

F. Provided staff with training.

The staff have been trained with regard to worker right to know, basic chemical hygiene, and new chemical review and handling procedures. The staff have also been advised to reexamine their procedures involving the use of chemicals and to seek less toxic alternatives. The increased training and awareness has achieved limited success in promoting procedure changes and chemical substitutions. A resistance to change has been noted in this area. In addition, the use of chemicals by the staff continues to occasionally impact the air quality at the school.

Facilities Maintenance

A. Reviewed issues associated with inventory.

A review of the chemical inventory maintained by the facilities maintenance staff determined that the department did not maintain an accounting of the materials it possessed. In addition, the department tended to acquire small batches of related products with similar uses while rarely consuming all the materials. As a result, the department was overstocked and not in compliance with the Massachusetts Right to Know record keeping requirements. Furthermore, their approach to chemical

management had resulted also in the accumulation of a large volume of flammable petroleum based cleaning products. Another concern noted was that many materials were stored in the warehouse without regard to chemical compatibility and therefore posed a significant risk to local emergency responders.

B. Improved oversight of chemical acquisition.

As the result of improved training and guidance, the facilities maintenance department has reduced its chemical inventory and virtually eliminated its use of petroleum based products. This reduction was achieved by implementing chemical purchasing controls, consumption of useful materials, and the disposal of obsolete or degraded materials. A one time chemical clean out was also conducted to remove major fire hazards and prohibited items. During this effort we disposed of 50 pounds of various pesticides and over 350 gallons of methanol duplicating fluid. The department has also decreased its willingness to accept free samples or test quantities from suppliers.

C. Modified chemical storage with regard to chemical compatibility.

The staff have been trained and advised in the need to store materials with regard to chemical compatibility. The department is also exploring the suggestion of constructing or designating storage areas within the warehouse which are based on general chemical classes and compatibilities. Unfortunately, the transient nature of the materials moving through the high school warehouse area and low level of importance given this task by the staff has made this a difficult issue to resolve.

D. Established a chemical use review policy.

All materials utilized by the facilities maintenance department are subject to the chemical use review policies adopted for the school system. It is now the responsibility of the director of the facilities maintenance department in addition to the School Chemical Oversight Committee to review and monitor chemical use by the department for the following parameters: a) health and safety hazards, b) potential impact on air quality, c) need for protective equipment, and d) the generation of hazardous waste.

E. Established a hazardous waste management plan.

The facilities maintenance department fulfills a critical function in supervising the implementation of the school department hazardous waste management plan. The department is responsible for maintaining the central hazardous waste storage area and for relocating departmental wastes to this location. Several staff members have been provided with 8 hour First Responder training as defined in 29 CFR 1910.120, the Occupational Safety and Health Administration HAZWOPER Standard, as well as additional training to ensure the proper management of hazardous waste. In addition, the disposal of all hazardous waste generated by the School Department is now carried out in conjunction with the regular municipal hazardous waste disposal program at programmed intervals. It is the intent of the town to insure that the school system maintains the generator status of a very small quantity generator (or conditionally exempt small quantity generator) at all times. The incorporation of the school's hazardous waste disposal activities into the existing town program has significantly enhanced our ability to promote the safe and proper disposal of hazardous materials.

Middle and elementary schools.

A. Reviewed hazards associated with chemical inventories.

I conducted a chemical hygiene review of the inventories maintained by the middle and elementary schools. Significantly fewer hazards were found at these schools primarily due to the decreased size of the chemical inventories present. The chemical hazards present at the middle school were associated with the chemical inventories maintained by the science and arts departments. Fortunately, the smaller inventory combined with the reliance on more benign household products for chemical experiments and demonstration lowered the risk factor associated with the inventory.

In addition, the arts department also maintained only a small chemical inventory. Fortunately, the art instructors had already converted the bulk of their inventory to low toxicity materials.

The chemical hazards present at the elementary schools were even less due to the limited amount of chemicals present. Art supplies were the primary chemical components present at the elementary schools. Again, the staff had already recognized the potential hazards and converted their materials to approved low toxicity materials.

Cleaning and maintenance supplies also represented a potential hazard at these schools. These hazards were controlled and reduced by limiting and securing the quantities stored on site and by consolidating the bulk storage of these materials at the high school warehouse.

A significant hazard that was noted at the middle and elementary schools was the presence of poorly identified hazardous materials in prepackaged instructional kits designed for the nonscientist. Concentrated acids, poisons, and carcinogens were found in educational kits designed for grade levels K through 8. Often times chemicals solutions were simply labeled: "Solution A, Do not consume, Poison." Frequently, these kits provided only a generalized description of the safety hazards associated with the materials contained in the kit. This lack of information could seriously hinder medical aid and emergency response in the event of an accident. Also, the merit for using some of these materials at the intended age level is questionable. I urge all instructors to carefully review the contents of these kits and the hazards associated with the test materials before purchasing and using the kits.

B. Assessed classroom setting and availability of safety equipment.

Our safety evaluation also included a review of the how the classrooms were equipped and the safety practices utilized by the staff. During this assessment, I found that the majority of the classrooms were not equipped with emergency eyewash units or chemical fume hoods. We also noted a significant shortage in terms of safety glasses, protective gloves and aprons. During training sessions, we reviewed the need to use and maintain various safety equipment. We also reminded the staff of the Massachusetts state law requiring the use of protective eyewear when chemicals are used in an educational setting. As a result of this review, new safety supplies were purchased so that each classroom was equipped with an emergency eyewash and an adequate amount of protective equipment. Based on the type of experimentation conducted by the staff, it was determined that the potential impact on air quality was minimal and as a result the widespread availability of a chemical fume hood was not considered critical at the middle school level at this time.

C. Established a chemical use review policy.

All materials utilized within the middle and elementary schools are subject to the chemical use review policies adopted for the school system. It is now the responsibility of the instructional team leaders and the School Chemical Oversight Committee to review and monitor chemical use by these staff members for the following parameters: a) health and safety hazards, b) potential impact on air quality, c) need for protective equipment, and d) the generation of hazardous waste.

D. Reviewed and improved chemical storage.

In general, the art supplies were found to be stored in one or two classrooms at each school. The major modification to the storage of these materials was to relocate these materials to lockable cabinets or closets and to label these areas for emergency responders. The individual classrooms at the elementary schools were inspected for educational kits containing chemistry. The bulk of this chemistry was disposed of as obsolete materials via the municipal hazardous waste disposal program. The chemical inventory maintained by the middle school science department was removed from the classrooms and relocated to a central secured storage closet as a means to enhance security and control.

E. Other hazard noted - kilns.

While reviewing the art supplies in the middle and elementary school, I noted that all the kilns located at these schools vented directly into the schools. As a result, carbon monoxide, volatile organic materials and other emissions were being released into the schools whenever the units were fired. This resulted in a degradation of the indoor air quality of these schools. This problem was addressed by installing the appropriate ductwork and exhaust fans to vent the units outside.

Systemwide

In addition to establishing departmental chemical review responsibilities, the School Committee also created a Chemical Oversight Committee. The intent of this was that the Oversight Committee would assist with the departmental reviews as needed and to monitor the quality of these reviews. This group also is available to provide technical assistance and guidance to school personnel.

Lessons learned:

The following is a summary of significant lessons I noted during the investigation of environmental, and health and safety issues involving the Burlington public school system.

1. Be persistent: Change does not come easily and as in our case if motivation for the changes comes from outside the school system it is likely that you will encounter greater resistance to change.
2. Inspect and verify: Two heads are better than one. Someone must review your actions in order to verify the accuracy and completeness of the task. In addition, the reviewer may have a different perspective and may note something that was originally overlooked.
3. Provide staff with training and guidance: The staff must be provided with training and guidance to understand the significance of EHS issues in the classroom and the potential hazards and liability associated with these concerns. Training should be conducted during the initial phase of investigating EHS issues so that the staff can participate with the investigation and resolution. Annual refresher training should also be initiated.
4. Establish staff accountability for chemical use and misuse: The school system should adopt formal policies requiring the staff to review chemicals and experimental procedures for EHS concerns. The school system should also adopt chemical storage requirements as a means to control access and prevent the theft of materials. This system will not prevent all accidents from occurring but it does provide accountability for overlooking obvious hazards and sloppy chemical management.
5. Review the text and reference materials used by the staff for instructions regarding EHS issues: When I reviewed the text and reference materials used by the staff, I found that most material prepared prior to 1985 did not provide a discussion of the EHS issues associated with chemical procedures. I also noted that the staff relied heavily on reference materials and chemical disposal guidance provided by their chemical supplier. I found the bulk of this information to be insufficient and frequently illegal. I recommend that every school system acquire text books and reference materials which describe proper chemical handling and disposal methods. You should also contact federal, state and local environmental, and health and safety agencies to determine if any more specific requirements exist for your area. In general, I would hesitate to dispose of any chemistry via a sanitary drain or to try to chemically neutralize any material without first consulting your regional agencies.

Tips and suggestions:

1. Use a smoke bomb to test mechanical ventilation: This simple and inexpensive test can provide you with a quick and easy qualitative assessment of the function of a chemical fume hood or kiln exhaust. The use of brightly colored smoke will enable you to easily determine if exhaust may be escaping from the test unit, the ductwork associated with the unit, or if the exhaust is reentering other portions of your ventilation system. This is only a quick and dirty analysis designed to check for major problems. This approach does not replace the need to have a trained professional inspect, maintain and calibrate these units.

2. Seek assistance from local resources: We are all in this together. Tap into the assistance that is available from federal, state and local environmental, and health and safety agencies. Do not overlook local residents, corporations, and medical facilities. These groups have a vested interest as parents and tax payers, and are frequently willing to provide technical expertise and assistance.

3. Consider chemical compatibility when storing your inventory: Do not store your materials in alphabetical order but by chemical hazard classification. Failure to consider chemical compatibility prior to storage could cause reactive materials to be stored together and result in a small fire becoming a catastrophic hazardous materials incident. Your emergency responders will appreciate your efforts. For your reference Flinn Scientific Incorporated of Batavia, Illinois (1-800-452-1261) provides a chemical storage plan based on chemical compatibility in their supply catalog. *(Please note: EPA does not endorse specific vendors. This information is provided by the Burlington Board of Health as one potential source of assistance.)*

4. Adopt a microscale curriculum: The microscale concept is to alter your experimental procedures so that you use approximately 1/10th of the amounts originally planned for by the author. Conversion to microscale may require the purchase of new glassware, however the benefits include the development of better techniques by the staff and students, decreased chemical usage, lowered exposure to hazardous materials, and a reduction in hazardous waste generated. For more information describing microscale contact: Dr. Mono M. Singh, Director, The National Microscale Chemistry Center, 315 Turnpike Street, Merrimack College, North Andover, Massachusetts 01845, Telephone: (978)837-5137, Fax: (978)837-5017, or via e-mail at 'msingh@merrimack.edu'.

5. Adopt a less toxic curriculum: As I mentioned in item 5 of the lessons learned, you must review the curriculum to determine if safer, less toxic alternatives can be implemented. I have found that frequently many options exist for providing the same educational experience, however some motivation must be provided to prompt the search for a safe alternative. I recommend that you consult your state pollution prevention agencies for assistance. In Massachusetts, we are fortunate to have the Office of Technical Assistance and Surface Cleaning Laboratory. These agencies provide free, non-regulatory pollution prevention assistance to the public. In Burlington, we have also adopted a number of procedures presented in "40 Low-waste, Low Risk Chemistry Labs", by David Dugan, published by J. Weston Walch of Portland, Maine (207-772-2846). We have found this text to provide a more detailed discussion of EHS issues associated with the procedure combined with the use of less toxic alternatives than normally found in most chemistry text books.

6. Hazardous chemicals: During my travels, I have encountered several lists of high risk science chemicals. The following is a compilation of these lists. This list is illustrative and is not an exhaustive list of potentially hazardous chemicals. Each chemical requires thorough risk evaluation by a qualified professional prior to use.

Explosive/fire hazard		
potassium chlorate	benzoyl peroxide	carbon disulfide
collodion	cyclohexene	1,4-dioxane
ethyl ether	isopropyl ether	tetrahydrofuran
styrene	phosphorus pentoxide	yellow/white phosphorus magnesium powder
formic acid (aged)	anhydrous aluminum chloride	lauryl peroxide
potassium metal	nitroglycerin	nitrogen trioxide
2,4-dinitrophenol	2,4-dinitrophenolhydrazine	perchloric acid
low flash point solvents	aged & excessive oxidizers	thermit
picric acid	leaking gas cylinders	sodium metal
lithium metal	divinyl acetylene	vinylidene chloride
sodium amide	acetalmethyl i-butyl ketone	ethylene glycol
dimethyl ether (glyme)	vinyl ethers	dicyclopentadiene
diacetylene	methyl acetylene	cumene
tetrahydronaphthalene	methylcyclopentane	t-butyl alcohol
butadiene	tetrafluoroethylene	vinyl acetylene
vinyl acetate	vinyl chloride	vinyl pyridine
chlorobutadiene/chloroprene	indene	furan
all peroxides	all isocyanates	picramide
isoprene	all aliphatic ethers	aminoguanidine nitrate
ammonium dichromate	calcium carbide	cyclohexane
methyl ethyl ketone	methyl methacrylate	petroleum ether
phosphorus, red	potassium chlorate	sodium azide
sodium sulfide	toluene	xylene

Reactives		
bromine	hydrofluoric acid	titanium tetrachloride
osmium compounds	aluminum chloride	antimony trichloride
lead nitrate	lithium, metal	lithium chloride
potassium, metal	potassium chlorate	sodium, metal
potassium permanganate	sodium chlorate	sodium chromate tetrahydrate
sodium dichromate	sodium nitrite	sodium sulfide
stannic chloride	nitric acid	sulfuric acid
hydrochloric acid	uranyl nitrate	

	Toxic	
ammonium metavanadate	caffeine	colchicine
lead compounds	mercury	mercury compounds
nicotine	sodium azide	cyanide salts
thioacetamide	thiourea	brucine sulfate
unsealed radioactive sources	o-toluidine	ammonium oxalate
antimony	antimony trioxide	arsenic trichloride
arsenic trioxide	barium chloride	calcium fluoride
chloretone	chloroform	chromium oxide
chromium potassium sulfate	cobalt nitrate hexahydrate	cyclohexane
p-Dichlorobenzene	dichloromethane	lead arsenate
lead carbonate	lead chloride	lead nitrate
lithium nitrate	methylene chloride	nickel powder
selenium	silver nitrate	sodium arsenate, dibasic
sodium fluoride	sodium oxalate	stannic chloride
uranyl acetate	uranyl nitrate	wood's metal (lead alloy)
thorium nitrate	uranium tetrachloride	

	Carcinogens	
arsenic	carbon tetrachloride	benzene
formaldehyde	chloroform	aniline
lead acetate	acetamide	acrylamide
antimony trioxide	arsenic and compounds	beryllium & compounds
cadmium & compounds	calcium chromate	carbon black
chromium & compounds	cobalt & oxides	lead phosphate
mercury alkyl compounds	methyl chloride	nickel & soluble compounds
thorium & compounds	titanium dioxide	o-toluidine
o-toluidine	trypan blue	acrylonitrile
ammonium chromate	ammonium dichromate	aniline hydrochloride
ethylene dichloride	hematoxylin	potassium chromate
sodium chromate tetrahydrate	sodium dichromate	sudan IV
talc	tannic acid	thioacetamide

7. Encourage chemical suppliers to post MSDS's on internet: In order to enhance your accessibility to chemical information, I urge you to encourage your suppliers to post their MSDS databases on the Internet. A number of colleges and universities have begun this effort. Your support and assistance will further the cause and enhance the ability of emergency responders and medical personnel to respond to a chemical accident. Under the heading of Internet resources, I have listed several organizations that maintain MSDS databases on the Internet. Most of these groups are willing to add new information to their existing database. I encourage you to support their efforts.

Resources

1. Internet resources: The following is a compilation of useful Internet addresses that may assist you when researching EHS or regulatory issues. Please note that several of these sites maintain accessible MSDS databases for your use. These providers will also accept any new MSDS's that you or your supplier may be able to provide.

Address:	Site Description:
http://www.osha.gov/oshasoft <small>EXIT disclaimer ></small>	OSHA regulations & software (fire, asbestos)
http://www.turi.org <small>EXIT disclaimer ></small>	Mass Toxic Use Reduction Institute
http://www.cleaning.org <small>EXIT disclaimer ></small>	Mass Surface Cleaning Lab
http://www.cdc.gov <small>EXIT disclaimer ></small>	NIOSH info & toxicological registry
http://www.access.gpo.gov <small>EXIT disclaimer ></small>	federal government printing office
http://www.acs.org <small>EXIT disclaimer ></small>	American Chemical Society
http://www.instantref.com/tox-chem.htm <small>EXIT disclaimer ></small>	chemical management info
http://chemfinder.camsoft.com <small>EXIT disclaimer ></small>	searchable chemical database
http://es.epa.gov	pollution prevention info
http://www.lib.uchicago.edu/~atbrooks/safety <small>EXIT disclaimer ></small>	chemical safety collection
http://www.aiha.org <small>EXIT disclaimer ></small>	American Industrial Hygiene Association
http://oshweb.me.tut.fi/index.html <small>EXIT disclaimer ></small>	index of health & safety resources on net
http://www.artswire.org <small>EXIT disclaimer ></small>	Center for Safety in the Arts
http://www.iarc.fr <small>EXIT disclaimer ></small>	International Cancer Registry
http://www.ABIH.org <small>EXIT disclaimer ></small>	American Board of Industrial Hygiene
http://www.pdc.cornell.edu <small>EXIT disclaimer ></small>	large MSDS database
http://www.purdue.edu/PhysFac/rem <small>EXIT disclaimer ></small>	chemical hygiene plan
http://www.chem.uky.edu/resources/msds.htm <small>EXIT disclaimer ></small>	MSDS database

<http://www.siri.org> 

EHS bonanza,
MSDS's &
much more
safety auditing
guidance

<http://www.princeton.edu/~ehs/h&sguide/> 

2. Reference books: I found the following books to be useful when evaluating the chemical hazards present within the Burlington school system.

"Sax's Dangerous Properties of Industrial Materials", eighth edition, 1992, Richard J. Lewis, Sr. editor, Van Nostrand Reinhold, New York, New York.

"Handbook of Toxic and Hazardous Chemicals and Carcinogens", third edition, 1991, Marshall Sittig editor, Noyes Publications, Park Ridge, New Jersey.

"Fire Protection Guide to Hazardous Materials", eleventh edition, 1994, National Fire Protection Association, One Batterymarch Park, Quincy, Massachusetts 02269.

Flinn Scientific Supply Catalog, Batavia, Illinois 60510, (800)452-1261 - Chemical Storage Guidance.

"Pocket Guide to MSDS's and Labels", and "Pocket Guide to Your Right to Know", Business and Legal Reports, Inc., 39 Academy St., Madison, CT 06443, (800)727-5257.

3. Potential sources for written guidance describing school EHS issues:

The Maryland Department of Education has publish a number of helpful technical bulletins describing potential EHS issues in schools as well as potential corrective action.

Maryland Department of Education Office of Administration and Finance Office of School Facilities 200 West Baltimore Street Baltimore, Maryland 21201 (301)333-2508

The Center for Safety in the Arts monitors and evaluates a broad range of health and safety concerns involving the arts and theater. This group has also published a large volume of health and safety guidance.

Center for Safety in the Arts 5 Beekman Street, Suite 820 New York, New York 10038 (212)227-6220

The National Microscale Center at Merrimack College has prepared guidance describing the benefits as well as how to initiate a microscale curriculum. The center also conducts training for those wishing to develop a microscale program.

Dr. Mono M. Singh, Director The National Microscale Chemistry Center 315 Turnpike Street Merrimack College North Andover, Massachusetts 01845 Telephone: (978)837-5137 Fax: (978)837-5017 e-mail at 'msingh@merrimack.edu'.

101 WAYS TO REDUCE HAZARDOUS WASTE IN THE LABORATORY

1. Write a waste management/reduction policy.
2. Include waste reduction as part of student/employee training.
3. Use manuals such as the American Chemical Society (ACS) "Less is Better" or "ACS Waste Management Manual for Lab personnel" as part of your training.
4. Create an incentive program for waste reduction.
5. Centralize purchasing of chemical through one person in the lab.
6. Inventory chemicals at least once a year.
7. Indicate in the inventory where chemicals are located.
8. Update inventory when chemicals are purchased or used up.
9. Purchase chemicals in smallest quantities needed.
10. If trying out a new procedure, try to obtain the chemicals needed from another lab or purchase a small amount initially. After you know you will be using more of this chemical, purchase in larger quantities.
11. Date chemical containers when received so that older ones will be used first.
12. Audit your lab for waste generated (quantity, type, source and frequency).
13. Keep MSDS's for chemicals used on file.
14. Keep information about disposal procedures for chemical waste in your lab file.
15. If possible, establish an area for central storage of chemicals.
16. Store chemicals in storage area except when in use.
17. Establish an area for storing chemical waste.
18. Minimize the amount of waste kept in storage.
19. Label all chemical containers as to their waste.
20. Develop procedures to prevent and/or contain chemical spills. Purchase spill clean-up kits, contain areas where spills are likely.

Segregate your wastes:

21. Keep halogenated solvents separate from non-halogenated solvents.
22. Keep recyclable waste/excess chemicals separate from non-recyclables.

23. Keep organic wastes separate from metal-containing or inorganic wastes.
24. Keep non-hazardous chemical wastes separate from hazardous waste.
25. Keep highly toxic wastes (cyanides, etc.) separated from above.
26. Avoid experiments that produce wastes that contain both radioactive and hazardous chemical waste.
27. Keep chemical waste separate from normal trash (paper, wood, etc.).
28. Use the least hazardous cleaning method for glassware. Use detergents such as Alconox, Micro, RBS35 on dirty equipment before using KOH/ethanol bath, acid bath or No Chromix.
29. Eliminate the use of chromic acid altogether.
30. Eliminate the use of uranium and thorium compounds (naturally radioactive).
31. Substitute red liquid (alcohol) thermometers (range up to 150 c) for mercury thermometers where possible.
32. Use metal oven thermometer instead of mercury thermometer in ovens.
33. Use digital thermometer where possible.
34. Evaluate laboratory procedures to see if less hazardous or non-hazardous reagents could be used.
35. Review the use of highly toxic, reactive, carcinogenic or mutagenic materials to determine if safer alternatives are feasible.
36. Avoid the use of reagents containing: barium, arsenic, cadmium, chromium, lead, mercury, selenium and silver.
37. Consider the quantity and type of waste produced when purchasing new equipment.
38. Purchase equipment that enables the use of procedures that produce less waste.
39. Review your procedures regularly (e.g. annually) to see if quantities of chemicals and/or chemical waste could be reduced.
40. Look into the possibility of including detoxification and/or waste neutralization steps in laboratory experiments.
41. When preparing a new protocol, consider the kinds and amounts of waste products and see how they can be reduced or eliminated.
42. When researching a new or alternative procedure, include consideration of the amount of waste produced as a factor.
43. Examine your waste/excess chemicals to determine if there are other uses if your lab,

neighboring labs, departments or areas (garage, paint shop) who might be able to use them.

44. Review the list of chemicals to be recycled or contact the chemical recycling coordinator to see if these materials are available elsewhere within the school department.
45. Inform the chemical recycling coordinator of the types of materials you can use from the recyclables.
46. Call the chemical recycling coordinator to discuss setting up a locker or shelf for excess chemical exchange in a lab, stockroom or hallway in your department.
47. When solvent is used for cleaning purposes, use spent solvent for initial cleaning and fresh solvent for final cleaning.
48. Try using detergent and hot water for cleaning of parts instead of solvents.
49. Consider using ozone treatment for cleaning of parts.
50. Consider purchasing a vapor degreaser, vacuum bake or bead blaster for cleaning of parts.
51. Reuse acid mixtures for electropolishing.
52. When cleaning substrates or other materials by dipping, process multiple items in one day.
53. Use smallest possible container for dipping or for holding photographic chemicals.
54. Use best geometry of substrate carriers to conserve chemicals.
55. Store and reuse developer in photo labs.
56. Precipitate silver out of photographic solutions for reclamation.
57. Neutralize corrosive wastes that do not contain metals at the lab bench as part of the experiment.
58. Deactivate highly reactive chemicals in a fume hood.
59. Evaluate the possibility of redistillation of waste solvents in your lab.
60. Evaluate other wastes for reclamation in labs.
61. Scale down experiments producing hazardous waste wherever possible.
62. Convert to microscale experiments wherever possible.
63. Use demonstrations or video presentations as a substitute for some experiments that generate chemical waste.
64. Use pre-weighed or pre-measured reagent packets for introductory labs where waste generation is high.

65. Include waste management as part of the pre and post laboratory written procedure.
66. Maintain a neat and tidy lab.
67. Polymerize epoxy waste to a safe solid.
68. Consider using solid phase extractions for organics.
69. Rotavape hexane for reuse.
70. Destroy ethidium bromide using NaNO_2 and hypophosphorus acid.
71. Run mini SDS-PAGE 2d gels instead of full size slabs.
72. Treat sulfur and phosphorus wastes with bleach before disposal.
73. Treat organolithium waste with water or ethanol.
74. Seek alternatives to phenol extractions (e.g. small scale plasmid prep using no phenol may be found in Biotechnica, Vol. 9, No. 6, pp. 676-678).
75. Use procedures to recover metallic mercury.
76. Review procedures to recover mercury from mercury containing solutions.
77. Recover silver from silver chloride residue waste.

Use the following substitutions where possible:

<u>Original Material</u>	<u>Substitute</u>	<u>Comments</u>
78. Acetamide	Stearic acid	in phase change & freezing point depression
79. Benzene	Alcohol	
80. Benzoyl peroxide	Lauryl peroxide	when used as a polymer catalyst
81. Chloroform	1,1,1-trichloroethane	
82. Carbon tetrachloride	Cyclohexane	in test for halide ions
83. Carbon tetrachloride	1,1,1-trichloroethane 1,1,2-trichloro-trifluoroethane	

Use the following substitutions where possible:

<u>Original Material</u>	<u>Substitute</u>	<u>Comments</u>
84. Formaldehyde	Peracetic acid	for cleaning kidney dialysis machines
85. Formaldehyde	“Formalternate” (Flinn Scientific)	for storage of biological specimen
86. Formaldehyde	Ethanol	for storage of biological specimen
87. Formalin	See formaldehyde	
88. Halogenated solvents	Non-halogenated solvents	in parts washers or other processes

- | | | |
|-----------------------|--|-------------------------------|
| 89. Sodium dichromate | Sodium hypochlorite | |
| 90. Sulfide ion | Hydroxide ion | in analysis of heavy metals |
| 91. Toluene | simple alcohols and ketones | |
| 92. Wood's metal | Onion's Fusible alloy | |
| 93. Xylenes | simple alcohols and ketones | |
| 94. Xylene or toluene | Non-hazardous proprietary liquid scintillation cocktails | in radioactive tracer studies |
| 95. Fluorinert | Non-volatile, reusable pressurizing fluid | CS ₂ |
96. Purchase compressed gas cylinders, including lecture bottles, only from manufactures who will accept the empty cylinders back.
97. Limit the amount of chemical donations accepted.
98. Return excess chemistry to the distributor.
99. Replace and dispose of items containing polychlorinated biphenyls (PCB's).
100. Identify equipment containing Universal Waste (e.g. mercury, PCB's, lead). Label these items to indicate what components may need special handling or disposal. Sample items include: fluorescent lamps, computer and electronic components, mercury switches, ballasts, and batteries.
101. Send us other suggestions for waste reduction.

This list was originally prepared by the Division of Environmental Health and Safety at the University of Illinois at Urbana-Champaign for use by the laboratories at that university. The information provided in this list should be used only as a guide. Consideration for the general condition of your facility and the knowledge and experience of your staff will determine which of these suggestions may be appropriate for your school system.

School Hazardous Materials List

This list is a summary of chemicals which a variety of sources have suggested may not be appropriate for use in a high school or middle school setting. The final determination whether these materials may be safely used in your school can only be made after evaluating the following: 1) the health and safety considerations associated with the procedure involving the substance; 2) the training and experience of the staff; 3) the design and layout of the safety features (e.g. fume hoods, eye washes, ventilation) at your school; 4) the personnel protective equipment available at the school; and 5) your ability to respond to spills and manage the waste generated by the materials use. If there are any doubts regarding your ability to address any of these issues then it is probably wisest not to use these materials.

This list should only be used for reference purposes. Additional hazards may be associated with the substances record on this list. The chemical user should consult the material safety data sheet prepared by the manufacturer or additional reference materials before making a final decision.

Explosive/fire hazard

a,a,di-(nitroxy)methyl ether	azotetrazole (dry)
acetal (P)	barium azide
acetyl peroxide	benzine diazonium chlorate
acetylene silver nitrate	benzine diazonium nitrate
aged & excessive oxidizers	benzoxidazole
all aliphatic ethers (P)	benzoyl azide
all isocyanates (P)	benzoyl peroxide
all peroxides (P)	biphenyl triazonide
alumin picrate	bis-trinitroethylcarbonate
amatol	bis-trinitroethylnitramine
aminoguanidine nitrate (P)	black powder
ammonal	bromine azide
ammonium azide	1-bromo-2-nitrobenzene
ammonium bromate	bromodinitrobenzene
ammonium chlorate	4-bromo-1,2-dinitrobenzene
ammonium dichromate	bromosilane
ammonium fulminate	butadiene (P)
ammonium nitrate/fuel oil mixture	butanetrioltrinitrate
ammonium picrate	butyl tetryl
ANFO	calcium carbide
anhydrous aluminum chloride	carbazide
azaurolic acid	carbon disulfide
azido dithiocarbonic acid	chlorine azide
azido ethyl nitrate	chlorine dioxide
azido guanidinopicrate (dry)	chlorobutadiene/chloroprene (P)
azido propylene glycoldinitrate	chlorotrifluorethylene (P)
azido-1-hydroxy tetrazole	collodion
	composition A-3 (91% RDX, 9% wax)

composition B (40% TNT, 605 RDX)
 composition C-4 (91% RDX, 9% plastic)
 copper acetylide
 copper amine azide
 copper myxin
 copper tetramine nitrate
 cumene (P)
 cyanuric triazide
 cyclic 1,3,5,7 tetramethylene tetranitramine
 cyclohexane
 cyclohexene (P)
 cyclotetramethylene tetranitramine
 cyclotol (75% RDX, 25% TNT)
 di-(1-hydroxytetrazole)
 di-(1-naphthoyl) peroxide
 di-(beta-nitroxyethyl)
 di-iodoacetylene
 diacetylene (P)
 diaminonitrobenzene
 diaminotrinitromethylene tetranitramine
 1,2 diazidoethane
 diazoaminotetrazole (dry)
 diazodinitrophenol
 diazodiphenylmethane
 diazomium nitrate (dry)
 diazonium perchlorate (dry)
 diazopropane
 dibromoacetylene
 dichloroazidicarbonamide
 dichloroacetylene
 dicyclopentadiene (P)
 diethyl gold bromide
 diethyl peroxide
 diethylene glycol dinitrate
 dihydroxy-2,4,5,7-tetranitroanthroquinone
 diiodoacetylene
 diisopropyl ether
 dimethylhexane dihydroperoxide (dry)
 dimethyl dihydroperoxy hexane
 dinitrobenzylamide
 1,3-dinitro-5,5-dimethyl hydantoum
 1,3-dinitro-4,5-dinitrobenzene
 dinitroethane
 dinitroethyleneurea
 dinitroglycerine
 dinitroglycoluril
 dinitromethane
 dinitropentanonitrile
 dinitrophenates

dinitrophenoxy starch (dry)
 2,2-dinitropropyl acrylate
 dinitropropylene glycol
 dinitroresorcinol
 dinitrosalicylic acid
 dinitrosobenzylamide
 2,2-dinitrostilbene
 dinitrotetramethylolnutanetetranitrate
 dintro-7-8-dimethylglcoluril
 2,4-dinitrophenol
 2,4-dinitrophenolhydrazine
 2,4-dinitro-1,3,5-trimethylbenzene
 1,4-dioxane (P)
 diphenyl 1-picryl hydrazyl
 dipicrylsulfone
 divinyl acetylene (P)
 ethanolamine dinitrate
 ethleneglycol dinitrate
 ethyl ether (P)
 ethyl hydroperoxide
 ethyl perchlorate
 ethyl-4,4-dinitropentanoate
 ethylene diamine diperchlorate
 ethylene glycol dimethyl ether (glyme) (P)
 formic acid (aged)
 fulminate of mercury (dry)
 fulminate of mercury (wet)
 fulminate of silver
 fulminating gold
 fulminating mercury
 fulminating platinum
 fulminic acid
 furan (P)
 galactsan trinitrate
 glycerol 1,3-dinitrate
 glycerol monogluconate trinitrate
 hexamethylene triperoxidediamine
 hexamethylol benzene hexanitrates
 hexanite
 hexanitro dihydroxazobenzene
 hexanitrodiphenyl ether
 hexanitrodiphenyl urea
 hexanitrodiphenylamine (dry)
 hexanitroethane
 hexanitrooxanilide
 hexanitrostilbene
 hexogen
 hydrazine azide
 hydrazine chlorate

hydrazine dicarbonic acid diazide
 hydrazine perchlorate
 hydrazine selenate
 hydrazinium nitrate
 hydrazoic acid
 hydroxyl amine iodide
 hydroxytetrazole
 hyponitrous acid
 indene (P)
 inositolhexanitate (dry)
 inulintrinitrate (dry)
 iodine azide
 iodoxy compounds (dry)
 iridium nitrate
 iridiumnitratopentamine
 isoprene (P)
 isopropyl ether (P)
 isothiocyanic acid
 lauryl peroxide
 lead azide
 lead mannite
 lead mononitroresorcinate (dry)
 lead picrate (dry)
 lead styphnate (dry)
 leaking gas cylinders
 lithium metal
 low flash point solvents
 m-nitrobenzene diazonium perchlorate
 m-nitrophenyldinitromethane
 m-phenylene diamine diperchlorate (dry)
 magnesium powder
 mannitan tetranitrate
 mercurous azide
 mercury acetylde
 mercury nitride
 mercury oxalate
 mercury tartrate
 methyl acetylene (P)
 methyl ethyl ketone
 methyl i-butyl ketone (P)
 methyl methacrylate
 methyl nitrate
 methyl picric acid
 methyl trimethylolmethane trinitrate
 methyl-4,4-dinitropentanoate
 methylamine dinitramine
 methylamine nitroform
 methylamine perchlorate
 methylcyclopentane (P)

methylene glycol dinitrate
 N,N-hexanitrodiphenyl ethylene dinitramine
 (dry)
 N-nitro-N-methyl-glycolamide nitrate
 naphthalene diozonide
 nickel picrate
 nitrated paper (unstable)
 nitrates of diazonium compounds
 nitro isobutanetrioltrinitrate
 nitro sugars (dry)
 nitroethylene polymer
 nitroethylnitrate
 1-nitrohydantoin
 nitrogen trichloride
 nitrogen triiodide
 nitrogen triiodidemonoamine
 nitrogen trioxide
 nitroglyceride
 nitroglycerin
 nitroglycerin (not desensitized)
 nitroguanidine (dry)
 nitroguanidine nitrate
 nitroisobutanetriolnitrate
 nitromannite (dry)
 nitrourea (dry)
 ocatgen
 octol (75% HMX, 25% TNT)
 p-diazidobenzene
 p-xylyl diazide
 pentaerythrite tetranitrate (dry)
 pentanitroaniline (dry)
 pentolite
 peracetic acid (not over 43%)
 perchloric acid
 petroleum ether
 phosphorus pentoxide
 phosphorus, red
 picramic acid (dry)
 picramide
 picramide (P)
 picratol
 picric acid (P)
 picric acid (dry)
 picryl chloride (dry)
 picryl fluoride
 picryl sulfonic acid (dry)
 PLX (95% nitromethane, 5% ethylenediamine)
 potassium carbonyl
 potassium chlorate

potassium dinitrobenzoforoxane
 potassium metal (P)
 potassium nitoraminotetrazole
 pyradine perchlorate
 quebrachitol pentanitate
 selenium nitride
 silver azide (dry)
 silver chlorate (dry)
 silver fulminate (dry)
 silver oxalate (dry)
 silver picrate (dry)
 silver styphnate
 silver tetrazene
 silver, acetylide (dry)
 sodatol
 sodium metal
 sodium amatol
 sodium amide (P)
 sodium azide
 sodium dinitro-ocresolate
 sodium picramate (dry)
 sodium picrylperoxide
 sodium sulfide
 sodium tetranitride
 styphnic acid
 styrene (P)
 sucrose octanitate
 t-butoxyl carbonyl azide
 t-butyl alcohol
 tetraazido benzene quinone
 tetraethylammonium perchlorate
 tetrafluoroethylene (P)
 tetrahydrofuran (P)
 tetrahydronaphthalene (P)
 tetramethylene diperoxide dicarbamide
 tetranitrocarbazole
 tetranitrodiglycerin
 2,4,6-tetranitro-N-methylaniline
 2,3,4-tetranitrophenol
 2,3,4-tetranitrophenolmethyl nitramine
 2,3,4-tetranitrophenolnitramine
 tetranitroresorcinol (dry)
 2,3,5-tetranitroso-1,4-dinitrobenzene
 2,3,5-tetranitroso nitrobenzene (dry)
 tetrazene (dry)
 tetrazolyl azide (dry)
 thermit
 TNT
 toluene

torpex
 tri(b-nitroxethyl)ammonium nitrate
 tridite
 triethylene glycol dinitrate
 triformoxine trinitrate
 1,3,5-trimethyl-2,4,6-trinitrobenzene
 trimethylene glycol diperchorate
 trimethylol nitromethane trinitrate
 trimethylolethane trinitrate
 trimonite
 trinitro-m-cresol
 trinitroacetic acid
 trinitroacetonitrile
 trinitroamine cobalt
 trinitroanisole
 trinitrobenzene (dry)
 trinitrobenzene sulfonic acid
 trinitrobenzoic acid
 trinitrochlorobenzene
 trinitrocresol
 2,4,6-trintro-3,5-diazidobenzene (dry)
 2,4,6-trinitro-1,3-diazobenzene
 trinitroethanol
 trinitroethyl formal
 trinitroethylnitrate
 trinitroethylorthocarbonate
 trinitroethylorthoformate
 trinitrofluoranone
 trinitrofluorenone
 trinitromethane
 trinitronaphthalene
 trinitrophenetol
 trinitrophenol
 2,4,6-trinitrophenylguanidine (dry)
 trinitrophenylmethylnitramine
 2,4,6-trinitrophenyl nitramine
 trinitroresorcinol (dry)
 trinitrotetramine cobalt nitrate (dry)
 trinitrotoluene (tnt)
 trintiroaniline
 tris, bis-bifluoraminepropane
 tritonal
 vinyl acetate (P)
 vinyl acetylene (P)
 vinyl chloride (P)
 vinyl ethers (P)
 vinyl pyridine (P)
 vinylidene chloride (P)
 xylenes

yellow/white phosphorus
z-minol-2 (40% ammonium nitrate, 40% TNT,
20% Al)

zirconium picramate

Reactives/Corrosive/Irritants

acetal aldehyde	nitric acid
acetic anhydride	osmium compounds
aluminum chloride	oxalic acid
ammonium dichromate	p-dichlorobenzene
ammonium oxalate	phosphorus (white)
antimony oxide	phosphorus pentoxide
antimony pentachloride	phthalic anhydride
antimony trichloride	potassium chlorate
bismuth trichloride	potassium chromate
bromine	potassium cyanide
calcium carbide	potassium fluoride
calcium fluoride	potassium hydroxide
calcium oxide	potassium permanganate
catechol (pyrocatechol)	potassium, metal
cupric bromide	sodium chlorate
diethyl phthalate	sodium chromate tetrahydrate
ethyl methacrylate	sodium cyanide
hexachlorophene	sodium dichromate
hydrochloric acid	sodium ferrocyanide
hydrofluoric acid	sodium hydroxide
hydrogen peroxide (30%)	sodium nitrite
hydrogen sulfide	sodium silicofluoride
hydroquinone	sodium sulfide
iodine (crystals)	sodium, metal
lead carbonate	stannic chloride
lead nitrate	sulfuric acid
lithium chloride	sulfuric acid fuming
lithium, metal	titanium tetrachloride
methyl ethyl ketone	titanium trichloride
methyl methacrylate	toluene
methyl salicylate	trichlorotrifluoroethane
naphthalene	uranyl nitrate

Toxic

adrenaline
ammonium metavanadate
ammonium oxalate
antimony
antimony trioxide
arsenic trichloride
arsenic trioxide
barium chloride
barium hydroxide
brucine sulfate
caffeine
calcium fluoride
chloretone
chlorine
chloroform
chromium oxide
chromium potassium sulfate
cobalt nitrate hexahydrate
colchicine
cyanide salts
cylcohexane
dichloromethane
lead arsenate
lead carbonate
lead chloride
lead compounds
lead nitrate
lithium nitrate
mercuric chloride
mercuric iodide
mercuric nitrate

mercuric oxide
mercuric sulfate
mercury
mercury compounds
methylene chloride
nickel powder
nicotine
o-toluidine
osmium tetroxide
p-dichlorobenzene
phosphorus (white)
phosphorus pentoxide
potassium cyanide
potassium periodate
selenium
silver cyanide
silver nitrate
sodium arsenate, dibasic
sodium azide
sodium cyanide
sodium fluoride
sodium oxalate
stannic chloride
thioacetamide
thiourea
thorium nitrate
unsealed radioactive sources
uranium tetrachloride
uranyl acetate
uranyl nitrate
wood's metal (lead alloy)

Carcinogens

Acetaldehyde	Benzal chloride
acetamide	benzene
Acetophenetidin	benzidine
Acetylaminofluorene	benzo[a]pyrene
Aciflourfen	Benzo[b]fluoranthene
acridine orange	Benzotrichloride
acrylamide	Benzyl chloride
acrylonitrile	beryllium & compounds
Actinomycin D	beryllium carbonate
Adriamycin	Bis(chloromethyl ether)
Afiatoxins	bromide
Alachlor	Busulfan
Aldrin	1,3-Butadiene
Allyl chloride	Butyl benzyl phthalate
Allyl isothiocyanate	Cadmium
2-Aminoanthraquinone	cadmium & compounds
Aminoazobenzene	Cadmium acetate
Aminoazotoluene	cadmium chloride
4-Aminobiphenyl	Cadmium oxide
3-Amino-9-ethylcarbazole	cadmium sulfate
1-Amino-2-methylanthraquinone	Calcium arsenate
4-Amino-2-nitrophenol	calcium chromate
3-Amino-1,2,4-triazole	Cantharidin
Amitraz	Captafol
ammonium chromate	Captan
ammonium dichromate	carbon black
aniline	carbon tetrachloride
aniline hydrochloride	Carmustine
Anisidines	Chlorammphenicol
anthracene	Chlordane
antimony oxide	Chlordecone
antimony trioxide	Chlornaphazine
arsenic	Chlorodifluoromethane
arsenic and compounds	chloroform
Arsenic oxide	Chloromethyl anilines
arsenic pentoxide	Chloromethyl methyl ether
arsenic trichloride	4-Chloro-o-phenylenediamine
arsenic trioxide	Chloroprene
Arsenic trisulfide	Chlorothalonil
Arsenic with inorganic compounds	Chromic acetate
Arsine	Chromic acid
asbestos	chromium & compounds
Auramine	chromium (VI) oxide
Azathioprine	Chromium carbonyl
Azobenzene	Chromium trioxide
B-Propiolactone	Chromyl chloride
Benz[a]anthracene	Chrysene

Cisplatin	Estradiol 17B
Coal tar pitch volatiles	Estrone
cobalt & oxides	Ethinylestradiol
colchicine	Ethyl acrylate
Conjugated estrogens	Ethylene dibromide
Crotonaldehyde	ethylene dichloride
Cupferron	ethylene oxide
Cycasin	Ethylene thiourea
Cyclophosphamide	Ethyleneimine
2,4-D	Fenthion
Dacarbazine	formaldehyde
Daminozide	Glycidyl aldehyde
DDT	Hematite
Diallate	hematoxylin
4,4'-Diaminodiphenylmethane	Heptachlor
Deimethyl terephthalate	Heptachlor epoxide
Di(2-ethylhexyl) phthalate	Hexachlorobenzene
Di-tert-butyl-p-cresol	Hexachlorobutadiene
2,4-Diaminoanisole	Hexachlorocyclohexane
Diazomethane	Hexachloroethane
Dibenz(a,h)anthracene	Hexamethylphosphoric triamide
Dibromochloromethane	Hydrazine
Dibromochloropropane	Hydrogen peroxide
Dichloroacetylene	hydroquinone
3,3'-Dichlorobenzidine and salts	Indeno(1,2,3-cd) pyrene
1,4-Dichloro-2-butene	indigo carmine
1,2-dichloroethane	Iron oxide fume
Dichloroethyl ether	Iron-dextran complex
2,4-Dichlorophenol	isophorone
1,2-Dichloropropane	lead acetate
1,3-Dichloropropane	lead arsenate
Dieldrin	Lead chromate
Diepoxybutane	lead diacetate
Diethyl carbamyl chloride	lead phosphate
Diethyl sulfate	Lindane
Diethystilbestrol	Lomustine
Dihydrosafrole	Maneb
3,3'-Dimethoxybenzidine	MCPA
Dimethyl carbamoyl chloride	Mechlorethamine
4-Dimethylaminoaxobenzene	Melamine
1,1-Dimethylhydrazine	Melphalan
1,2-Dimethylhydrazine	mercury alkyl compounds
Dimethyl sulfate	Methotrexate
Dinitronaphthalenes	Methyl bromide
2,4-Dinitrotoluene	methyl chloride
Dioxane	Methyl hydrazine
1,4-dioxane	Methyl iodide
1,2-Diphenylhydrazine	4,4-Methylene-bis(2-chloroaniline)
Direct Blue 6	4,4'-Methylene-bis(N,N-dimethyl)aniline
Epichlorohydrin	

Methylene chloride	Propyleneimine
Methylthiouracil	Propylene oxide
Metronidazole	pyrogalllic acid
Michler's ketone	Reserpine
Mirex	Saccharin
Mitomycin C	Safrole
Mustard gas	Selenium sulfides
1-Naphthylamine	semicarbazide hydrochloride
2-Naphthylamine	Silvex
5-Nitro-o-anisidine	sodium arsenate
N-Nitrosodimethylamine	sodium arsenite
N-Nitrosodiphenylamine	sodium azide
N-Nitrosodipropylamine	sodium chromate tetrahydrate
N-Phenyl-B-Naphthylamine	sodium dichromate
nickel & soluble compounds	sodium nitrate
nickel (II) acetate	Sodium selenite
Nickel carbonyl	Streptozotocin
Nickel hydroxide	Strontium chromate
Nitrapyrin	Styrene
Nitrilotriacetic acid	Styrene oxide
5-Nitroacenaphthene	sudan IV
4-Nitrobiphenyl	Sulfallate
Nitrofen	Sulfurous acid 2-(p-tert-butylphenoxy-1-methylethyl-2-chloroethyl ester
2-Nitropropane	2,4,5-T
o-toluidine	talc
osmium tetraoxide	tannic acid
4,4-Oxydianiline	TDE
9,10-oxydiphenoxarsine	Testosterone
p-Cresidine	Tetrachlorodibenzo-p-dioxin
p-Nitrochlorobenzene	1,1,1,2-Tetrachloroethane
Pentachloroethane	1,1,2,2-Tetrachloroethane
Pentachloronitrobenzene	Tetrachloroethylene
Pentachlorophenol	thioacetamide
Phenazopyridine and its hydrochloride	Thiotepa
Phenyl glycidyl ether	Thiourea
Phenylhydrazine	thorium & compounds
Phenytol	titanium dioxide
Picloram	toluene
Polybrominated biphenyls (PBBs)	Toluene 2,4-diisocyanate
Polychlorinated biphenyls (PCBs)	Toluene-2,4-diamine
Potassium arsenate	Toxaphene
Potassium arsenite	1,1,2-Trichloroethane
Potassium bromate	Trichloroethylene
potassium chromate	Trichlorophenols
potassium permanganate	Trinitrotoluene
Procarbazine	Tris(2,3-dibromopropyl) phosphate
procarbazine hydrochloride	trypan blue
Pronamide	Urethane
Propane sultone	Vinyl bromide

Vinyl chloride
4-Vinyl-1-cyclohexene
Vinyl cyclohexene dioxide
Vinylidene chloride

Vinylidene fluoride
Xylidines
Zinc chromate

(P) - symbolizes a potential generator of shock sensitive peroxides that should be handled with extreme care as a means to avoid accidental detonation.

B = beta

Sources:

“Handbook of Toxic and Hazardous Chemicals and Carcinogens”, Third Edition, Marshall Sitig, Editor, Noyes Publications, Park Ridge, New Jersey, 1991.

“School Science Laboratories - A Guide to Some Hazardous Substances”, a supplement to the NIOSH Manual of Safety and Health Hazards in the School Science Laboratory, U.S. Consumer Product Safety Commission, Washington, D.C., 1984.

Weekly Facility Inspection Report

Name of Inspector: _____ Date: _____

Name of Facility: _____

Hazardous Waste/Materials Management:

1. Are all containers properly labeled? Yes ___ No ___ Corrective Action Taken: _____

2. Are all containers sealed and free of leaks? Yes ___ No ___ Corrective Action Taken: _____

3. Are all flammable materials properly grounded or stored in flammable cabinets?
Yes ___ No ___ Corrective Action Taken: _____

4. Are any chemicals stored outside? Yes ___ No ___ Corrective Action Taken: _____

5. Are all chemicals stored on an impervious surface or in a containment structure? Yes ___ No ___
Corrective Action Taken: _____

6. Are the spill response kits accessible and fully stocked? Yes ___ No ___ Corrective Action Taken: _____

Inspection of Grounds and Facility:

1. Is there any evidence of chemical spillage or staining at the facility? Yes ___ No ___ Corrective Action Taken: _____

2. Have the fluids be removed from the abandon/obsolete equipment stored on site? Yes ___ No ___
Corrective Action Taken: _____

3. Are the floor drains and catch basins free of sand, debris, or discoloration? Yes ___ No ___
Corrective Action Taken: _____

4. Do the bays need to be swept to remove sand and sediment? Yes ___ No ___
Corrective Action Taken: _____

5. Are the on site monitoring wells accessible and free of damage? Yes ___ No ___
Corrective Action Taken: _____

6. Have the sand/debris piles been secured and protected to prevent the migration of sediment? Yes ___ No ___
Corrective Action Taken: _____

Inspection of Safety Equipment:

1. Are the fire extinguishers, deluge shower, & emergency eyewash accessible & operable? Yes ___ No ___
Corrective Action Taken: _____

2. Is personnel protective equipment available for individuals responsible for handling hazardous materials?
Yes ___ No ___ Corrective Action Taken: _____

Note the eyewash should be tested weekly and the deluge shower should be tested monthly to insure proper function of the device.

